

4.—THE WESTERN AUSTRALIAN VARIETIES OF *Eucalyptus oleosa* F. Muell. ex. Miq. AND THEIR ESSENTIAL OILS.

By

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I.—INTRODUCTION.

Amongst the species of *Eucalyptus* which prove difficult from the systematic viewpoint, two are outstanding because of their variability and the forms they assume. These are *Eucalyptus dumosa* A. Cunn., and *Eucalyptus oleosa* F. Muell. Both of them are species which have a wide geographical range, inhabiting many soil types and different environments. Recent workers on the genus have tended towards a narrower definition of species within the genus, and as a result considerable confusion has arisen, not only because of the variability of these species, but also because they have been established on characters which are not constant. In the case of *Eucalyptus oleosa* F. Muell., too much reliance has been placed on the shape and comparative size of the operculum and fruit, and these can be demonstrated to be extremely variable; furthermore, some of these recently described "species" have been established on incomplete material, and finally, the question of what *Eucalyptus oleosa* really is, *i.e.*, by reference to the specimens first described, has been largely overlooked.

It was a common practice amongst the botanists of the last century, to describe a new species from two or more separate collections without designating a type, thus sometimes such composite descriptions embraced more than one species; thus, in *Eucalyptus oleosa* we have a description based upon two separated localities, with no type specimen indicated, and no chosen lectotype.

The purpose of the systematic portion of this paper is an attempt to elucidate this question insofar as it concerns *Eucalyptus oleosa*, and to segregate the various forms found in Western Australia, with reference to the original description.

II.—HISTORY.

Eucalyptus oleosa F. Muell. ex Miq., was described in *Nederlandsch kruidkundig archief* iv. 128 (1856).

Following is the original description, in which I have substituted (for convenience, and for purposes of comparison) the metric system of measurement in place of the "inches" and "lines" employed in the original.

10, *Eucalyptus oleosa* F. Muell. *E. perforata* Behr, Herb. parte.
Eucalyptus strictae Sieb. affinis.

Marble Range (*Wilhelmi*); Murray Scrub (*Behr*).

Frutex, ramulis angulatis, foliis anguste lanceolatis vel sublineari-
bus in acumen uncinatum tenue vulgo saphacelatum excurrentibus,
basi attenuatis, ut plurimum inaequilateralis, coriaceis crebo pellucido-
glandulosis, venis subobtectis erecto-patulis, umbellis axillaribus,

4-10-floris pedunculo angulato sustentis, floribus breviter pedicellatis vel subsessilibus, operculo conico-hemisphaerico obtusiusculo tubum obeconico-turbinatum subaequante.

“Frutex hominem altus, coma laetissime viridi nitente” (*Behr*). Ramuli angulati albido-pallidi vel juniores saturate fusculi. Petioli 6-8 mm. longi in sicco luteoli. Folia 4-6.3 cm., vulgo circiter 5 cm. longa, 4-6 mm. lata, recta vel obliqua. Pedunculi 4 mm. vix aequantes. Calyx 3 mm. aequans, haud raro operculo sublongior, pallidus. Filamenta pallida.

There are two interesting points regarding the above description; in the first place it is based upon two separate collections, and in the second place it was described by Mueller ex Miquel in a European publication. It is suggested that Miquel who communicated the paper, may have been in part responsible for the description, since the Latin does not conform with Mueller's style (at least for his later descriptions). If this should prove to be the case, then the type sheets (or original specimens) were probably retained by Miquel, and are in some European Herbarium, probably that of Utrecht. This point is referred to later.

Mueller subsequently described *E. oleosa* (1860), again from mixed material, and giving *E. leptophylla* F. Muell. as a synonym, so that this description can be dismissed as being entirely unsatisfactory.

Diels (1905) makes no contribution in his references to this species, beyond giving the geographical range in Western Australia, but confuses the var. *glauca* with the var. *longicornis*. He makes notes on the affinities of the species.

It was next described by Maiden (1912), who, while drawing attention to the fact that the earlier descriptions were from mixed material, further complicates matters by including other forms, and speaks of the typical form without any reference to the original specimens, which he did not see. In discussing the range of *E. oleosa* he gives a number of Western Australian localities, extending from the Murchison River to Ravensthorpe, all belonging to his “typical form,” including one which he saw at Pindar, and which he describes as “a small tree with a rough dark flaky bark and smooth limbs, dark brown timber which is darker than is usually the case with *E. oleosa*.” Other references to *Eucalyptus oleosa* are found at intervals in Maiden's work, several varieties being described, all of which with the single exception of the var. *angustifolia* being subsequently raised to specific rank. These “species” are dealt with under the varieties proposed in this paper. *E. oleosa* var. *angustifolia* Maiden, was published without a description, but references were made to illustrations, amongst which two forms may be distinguished. It was Blakely (1934) who described it as follows:—

Small shrubs 1-2 metres high, with light glossy, green narrow-lanceolate leaves 5-7 cm. long, and 6-9 mm. broad. Buds cylindroid, 5 mm. long. Operculum sub-obtuse to obtuse. Fruit pedicellate, globular-pyriform, 4-5 by 4 mm., thick, with frail subulate protruding valves. The type is “Dublin Scrub, Pinnaroo, *J. M. Black*.”

J. M. Black (1926), in discussing the forms of *Eucalyptus oleosa*, states:—
“A form with very narrow glossy leaves, only 7-10 mm. broad, growing in the scrub near Pinnaroo, has a blunt conical cap, and 3-celled globular fruit, 4 mm. long, with a rather broad rim. It is only 1-2 metres high, and is locally called Green Mallee.”

These two descriptions should be compared with the original description. I can detect no essential points of difference between them, and conclude that the variety *angustifolia* Maiden, is identical with the original description, and would conform with the specimens from the Murray Scrub collected by Behr.

Burbidge (1947) makes the next contribution. A search in the Melbourne Herbarium having failed to reveal the original specimens, or specimens that could be identified as the original, a request was sent to the Utrecht Herbarium, and a photograph and some fragments were received. Burbidge states "It is mixed *E. uncinata* Turcz. (buds and flowers), and *E. oleosa* F. Muell. (immature fruits). The latter, which is regarded as the true type, was, according to the Melbourne authorities, collected from the Murray Mallee. When inquiries concerning the type was first made, it was hoped that the specimen would show the shape of the operculum, since this feature is variable, and has been the basis of differentiation in several varieties. Unfortunately this is still unsettled." Unfortunately Miss Burbidge makes no reference to the leaves of the Murray Mallee specimens, nor to the collector.

According to Burbidge, Blakely considered raising the var. *angustifolia* to specific rank under the name *E. lamprophylla*, but apparently he included in this all forms with an obtuse sub-cylindrical operculum, irrespective of other differences. This was not accomplished, but had it been done, tree forms with broadly lanceolate lustrous leaves from the Coolgardie district would have been included, which must be very different from the Pinnaroo Mallee. Burbidge described *E. oleosa sensu stricto*, as a mallee or small tree with a conical operculum longer than the cupular or semi-globular calyx-tube, the leaves narrow-lanceolate, usually glossy, 5-10 cm. long, and 1-2 cm. broad. The figures referred to this closely resemble the buds and fruits of the var. *longicornis* forma *gracilis*.

It will be seen from the above that apart from the original description, and the type material, to which reference has been made by only one subsequent writer, considerable confusion has accumulated round the species. The original material has not been redescribed, and as a result of speculation as to what *Eucalyptus oleosa* is, some variety, or varieties have come to be regarded as the typical form, while the only description which can be regarded as being comparable with the original description of the species, is that of the var. *angustifolia*.

III.—SYSTEMATIC.

Six distinct forms of *Eucalyptus oleosa* can be recognised in Western Australia. None of them agree with the original description of the species, and thus all of them are varieties. Of these, three have been described as species by Maiden—*Eucalyptus transcontinentalis* (var. *glauca* Maiden); *E. Kochii* (var. *Kochii* C. A. Gardn.), and *E. Grasbyi* (var. *longicornis* F. Muell. forma *gracilis*.)

The following key will serve to distinguish these varieties:—

- A. Leaves lustrous, or with a matt surface, not glaucous, drying greenish, yellowish or pale; operculum not attenuated-rostrate.
- B. Leaves spreading, with evident secondary nervation, and conspicuous dark oil-cavities (at least when dry); calyx-tube at anthesis abruptly contracted into the slender pedicel.

- C. Leaves dark green and lustrous ; pedicels longer than the calyx-tube.
- D. Operculum conical, acute, from as long as, to twice or more than twice the length of the calyx-tube.
α. var. longicornis F. Muell.
- D. Operculum hemispherical-cylindrical, very obtuse, sometimes apiculate-umbonate, often \pm wrinkled (at least when dry) about as long as the calyx-tube and usually different from it in colour.
β. var. obtusa C.A. Gardn.
- C. Leaves sublustrous, drying yellowish-green ; pedicels shorter than the calyx-tube at anthesis ; operculum obtusely conical to ovoid, subequal to the calyx-tube.
γ. var. borealis C.A. Gardn.
- B. Leaves, erect, rather rigid, the secondary nervation not evident in the mature leaf, the midrib showing as a narrow groove, the lamina never lustrous, drying pale ; oil-cavities never, or rarely seen on the mature leaf ; calyx-tube tapering into the angular pedicel.
- C. Leaves narrow-lanceolate to linear-lanceolate ; mature buds with a conical rather acute operculum as long as, or longer than the calyx-tube and paler in colour.
δ. var. Kochii C.A. Gardn.
- C. Leaves narrow-oblong, rarely oblong ; operculum hemispherical, very obtuse, rarely ovoid-hemispherical, shorter than the calyx-tube ; buds often large and robust ; pedicels \pm ancipitous, the angles (in the bud at anthesis) usually extending along the calyx-tube.
ε. var. plenissima C.A. Gardn.
- A. Leaves glaucous, broadly falcate-lanceolate ; secondary nervation rather distinct ; operculum ovoid, attenuated into a slender (rarely short) beak ; buds and fruits usu. glaucous.
ζ. var. glauca Maiden.

α. var. longicornis F. Muell. Fragm. xi. 14 (1878)

The „Morrel.” Typically a fairly large tree, attaining a height of 25 metres. Differs from the typical form in its size, broader dark-green leaves, and acutely conical operculum, which varies from more than twice the length

of the calyx-tube, to about an equal length. Its habitat extends from Carnamah in the north, thence its western boundary extends through Moora and Northam to Wagin, Katanning and Broome Hill to Gnowangerup. Eastwards it extends to beyond Southern Cross.

Eucalyptus Grasbyi Maiden and Blakely, described from a specimen collected at Lake Barlee by Fitzgerald Fraser, is a smaller, narrow-leaved and smaller flowered form of this variety (forma *gracilis*), and approaches to, if not the same as what Burbidge described as *E. oleosa* F. Muell. *sensu stricto*. The specimens are not in fruit, but I cannot separate it from the var. *longicornis* in anything but the size of the leaves and the inflorescence.

β. var. **obtusa** C. A. Gardn. var. nov.

Arbor elata ; foliis lanceolatis, nitentibus ; pedunculis tenuibus ; receptaculo cupulo quam operculum cylindrico-hemispherico subaequante, cetera typi.

Erect tree 7–13 metres tall, with widely spreading branches ; trunk to five metres tall and 45 cm. diameter, the bark, to a height of 3–4 metres persistent, close, pale grey, more tessellated than in the var. *longicornis*, and never very thick, that of the upper portions smooth and of a rich brown colour streaked with grey and decorticating in long ribbon-like strips often persisting as a rough collar at the summit of the rough-barked portion ; timber deep red and very hard. Branchlets terete or slightly angular. Leaves on petioles up to 1 cm. long ; lamina lustrous, lanceolate, acute or acuminate and uncinata, scarcely oblique at the base, and tapering into the petiole, copiously dark-dotted with oil-cavities, the midrib but slightly impressed on one surface, and raised on the other surface, the secondary nervation distinct, spreading widely and anastomosing with the intramarginal nerve which is remote from the margin. Peduncles axillary and lateral, terete, rather slender, 1 cm. long, 3–7-flowered, expanded at the top ; pedicels terete, 3–5 mm. long ; buds (at anthesis) ± oblong in outline, 7–8 mm. long ; calyx-tube hemispherical-cupular, 4 mm. long, abruptly contracted into the pedicel, smooth ; operculum darker in colour than the calyx-tube, cylindrical-hemispherical or cylindrical-ovoid, smooth, 4–4.5 mm. long and broad ; filaments pale. Fruit globular-hemispherical, 6 mm. long and broad.

Coolgardie district : Montana Hill, Coolgardie, in red stony soil, fl. m. October, *Gardner* 1839 (type) ; Widgiemooltha, in red loamy subsaline soil, *Gardner* 1754 ; Bremer Range, *Gardner* sine no.

Differs from the typical form of *E. oleosa* in being a comparatively tall tree with broader leaves, and very obtuse opercula.

γ. var. **borealis** C. A. Gardn. var. nov.

Arbor erecta ; foliis falcato-lanceolatis, subnitentibus ; punctatis, venis lateralibus pennato-patentibus, vena intramarginali a margine remota ; tubo calycis campanulato, ad basin obtusissimo ; operculo ovoideo-hemispherico, cetera typi.

Tree 10–17 metres tall, trunk up to one metre or more in diameter ; bark of the trunk and lower part of the branches dark grey, persistent, fibrous-lamellar, thick, ± spirally longitudinally fissured, the fissures narrow and deep, upwards thinly lamellar and almost ribbonous, the upper parts of the branches and branchlets terete or angular, smooth, spreading. Leaves

alternate, spreading, lanceolate-falcate, green, sub-lustrous but not shining, drying yellowish-green; petioles slender, up to 1 cm. long; lamina relatively thin, scarcely oblique at the base, tapering into the petiole, abruptly acuminate and uncinata, mostly 6–7 cm. long and 10–15 mm. broad, copiously punctate with dark oil-dots, the midrib scarcely impressed, the lateral nerves distinct, few, spreading, anastomosing with the intramarginal nerve which is removed from the marginal area. Umbels chiefly lateral; peduncles angular, 5 mm. long, rather slender, bearing mostly 5–7 flowers; pedicels 2–3 mm. long, terete or slightly angular, slender; buds at anthesis 6–7 mm. long. Calyx-tube campanulate, 3.5 mm. long, abruptly contracted into the pedicel, smooth and shining; operculum ovoid-obtuse, or very rarely ovoid-conical, 2.5–3 mm. long, smooth, usually paler in colour than the calyx-tube; filaments white; anthers as in the typical form; style 3 mm. long. Fruit globular-ovoid, 6–7 mm. long, and as much in diameter in the lower half, 3.5 mm. broad at the summit, the orifice 3 mm. wide; valves subulate, slender, exerted.

Habitat:—6–8 miles eastwards from Canna, on loamy reddish forest soil on flats, fl. m. Novem.-Jan., *Watson and Gardner* (Type), *Gardner* 8516, *L. R. Lovell* 5, 7, 9 and 10; eastwards from Gutha, on the Yalgoo Road, *Lovell*; Gutha, *Gardner*; 6 miles eastwards from Pindar, *Lovell and Gardner*.

Distinguished by the broad sublustrous thin spreading or pendulous leaves, non costate campanulate calyx, by the habit and dark-coloured bark, and the dark-punctate rather prominently nerved leaves. Differs from the var. *obtusata* in the paler and broader leaves, and the shape of the calyx and operculum.

From the vars. *Kochii* and *plenissima* it differs in the shape and texture of the leaves, as well as in their colour, in the campanulate calyx abruptly contracted into the pedicel, and generally in the shape of the operculum, as well as in the venation of the leaves, and their copious dark oil-dots.

♂. var. **Kochii** *C. A. Gardn.* var. nov.

Foliis lineari-lanceolatis; operculo conico cupulae aequali; frutex vel arbor; foliis opacis, acuminatis, epunctatis, nervo media vix prominulo, caeterum avenia.

A tree attaining a height of 12 metres, or a mallee of 2–5 metres, the tree with a grey fibrous ± latticed rough persistent bark on the trunk and lower portions of the branches, the upper parts and branchlets smooth and brownish-pink in colour, the branchlets pale or reddish, terete or slightly angular, the trunk up to 9 inches in diameter. Young leaves alternate lanceolate to ovate-lanceolate, glaucous-pruinose, subsessile, tapering at the base, the apex shortly acute and ± ustulate-mucronate, the midrib prominent (at least underneath), the intramarginal nerve remote from the edge of the leaf, the lamina 2–4 cm. long, 8–10 mm. broad.

Normal leaves alternate, oblong-linear to linear-lanceolate or almost linear, erect, the petiole yellowish, twisted, broad at the base, tapering upwards into the lamina, the lamina straight or slightly falcate, acute or acuminate, continued into a slender, usually uncinata point, usually 7–8 cm. long, 5–8 mm. broad, sublustrous or subglaucous, flat, the midrib narrow but fairly prominent and ± depressed on both surfaces, the lateral nerves not numerous, not evident, at an angle of about 45 degrees to the midrib, the intramarginal nerve removed from the margin, the marginal area thick, translucent, nerve-like, usually one margin reddish-coloured, the other pale.

Umbels axillary and lateral (through leaf-suppression), erect, solitary or rarely paired: peduncles stout, terete or slightly compressed, much thickened upwards, 7–8 mm. long, bearing usually 6–10 flowers; when young, with an expanded disc-like margin, when paired usually one long and one short; buds at first oblong in outline, later fusiform. Calyx-tube turbinate-obconical, tapering into the terete (later 2-angled) pedicel of 2–3 mm., the calyx 3.5–4 mm. long, pale when in blossom, 3.5 mm. diameter at the summit, sub-2-costate. Operculum conical, 4–5 mm. long, smooth, the commissural margin narrowly constricted, pale-coloured, acute, the apex straight or slightly curved, with a gland-like point. Stamens numerous, the filaments all fertile, pale yellow or almost white, twice as long as the calyx-tube; anthers erect, subquadrate, basally attached, obtuse, opening in short broad lateral \pm oval thecae. Fruit ovoid-truncate, smooth or becoming wrinkled when dry, somewhat abruptly tapering into the pedicel which is 2.5 mm. long, 6–7 mm. long, 5–6 mm. broad in the lower part, the summit 4 mm. broad; rim narrow, the orifice 3 mm. broad; disc vertical, 2 mm. long, lining the orifice; valves subulate, exerted, the tips breaking off below the orifice with age; seeds orbicular-obovate, compressed and sublenticular with acute angles, dark brown and smooth. Fl. m. January.—*E. Kochii* Maiden et Blakely.

Habitat:—10 miles eastwards from Pindar, *Gardner* 8518; eastwards from Perenjori, on the Dampierwah Road, *L. R. Lovell* 15; 5 miles E. from Dalwallinu, a mallee in sandy grey loamy soil, with *E. leptophylla* and *Melaleuca uncinata*, *Gardner* 8509; Rabbit-proof Fence, 25 m. E. from Dalwallinu, *Gardner* 8519, 8519a, 8524 (Type), 8525; Watheroo Rabbit Fence (probably the Dalwallinu gate locality previously quoted), *Max Koch*; 10 miles eastwards from Pithara, on the Kalannie Road, in reddish loamy soil with *Acacia acuminata* and *Melaleuca uncinata*, *Gardner* 8521; Rabbit-proof Fence, West from Kalannie, in wodjil country, *Gardner* 8535; 4 miles E. from Bunketch, a mallee in sandy soil, *Gardner* 8527; Rabbit-proof Fence, E. from Ballidu, *Gardner* 8538; between Kondut and Ballidu, *Gardner* 8539.

ϵ . var. **plenissima** C. A. Gardn. var. nov.

Frutex, vel arbor parva; foliis erectis lineari-oblongis, epunctatis, concoloribus, nec nitenti-viridibus neque glaucis; calyce turbinato, basin versus attenuato; operculo hemisphaerico, obtuso, cetera typi.

A bushy mallee 3–6 metres tall, and densely branched with erect-spreading densely foliated branches, the lower parts with a dark or pale grey \pm spirally fibrous bark, the upper parts with a smooth reddish-grey bark, or a tree 7–10 metres tall, with spreading branches, the trunk up to 40 cm. diameter, the bark of the trunk and branches pale or dark grey, fibrous and \pm spirally fissured, the fissures narrow and rather deep, that of the branches reddish-grey and decorticating in long plates. Leaves erect, the petiole up to 1 cm. long, the lamina oblong to linear-oblong, acute, never acuminate, uncinata, rather thick, drying pale, green in colour with a matt surface, without visible oil-glands when mature, up to 10 cm. long, rarely exceeding 1 cm. in breadth; more rarely elliptical-oblong and 1–2 cm. broad, the upper margin usually reddish, the lower pale; midrib impressed on both surfaces, the secondary nervation not evident in the mature leaf, the intramarginal nerve submarginal. Umbels axillary, mostly 6–8-flowered, peduncles stout, terete or angular, 5–8 mm. long, expanded at the top; buds obovoid-pyriform to obovoid-oblong, 7–8 mm. long; pedicels 2–4 mm. long. Calyx-tube campanulate-turbinate, 4–6 mm.

long, gradually tapering into the angular ancipitous pedicel, the angles of which usually extend for a greater or lesser distance up the calyx-tube, the tube otherwise smooth; operculum depressed-hemispherical to ovoid-hemispherical, up to 5 mm. broad, very obtuse or sometimes apiculate-umbonate, smooth, shorter than the calyx-tube; filaments, anthers and style as in the typical form. Fruit ovoid to urceolate-ovoid or globular-ovoid, on very short pedicels.

Habitat :—Rabbit-proof Fence, 1 mile South of the Pithara-Kalannie Road, *Gardner* 8520; Rabbit-proof Fence westwards from Kalannie, *Gardner* 8536; Rabbit-proof Fence eastwards from Ballidu, *Gardner* 8538a; near Kalannie, *Gardner* 8526; 4 miles eastwards from Mollerin, *Gardner* 1830; between Beacon and Wialki, in sandy soil, *Gardner* 8532 (Type); near Nembudding, 8542, Yorkrakine, 8543, North from Mukinbudin, and near Campion, *Gardner*.

var. **glauca** Maiden in *Journ. W.A. Nat. Hist. Soc.* iii. 171 (1911)

(*E. transcontinentalis* Maiden; *E. socialis* F. Muell.)

This tree is the "Redwood" of the Coolgardie district. It is described by Maiden as a "White Gum" with a blotched bark, and more or less shortly ribbony-flaky on the trunk, with a little roughness at the base. Examples with a perfectly smooth bark throughout are not uncommon, the bark decorating in long ribbon-like strips. On the other hand "half-barks" in which the greater part of the trunk is rough-barked, and specimens with all but the upper branches rough-barked, are not uncommon. The inflorescence is usually distinctly glaucous, and sometimes the fruits also, but in some specimens this glaucous "bloom" is wanting. The leaves, however, are never lustrous, varying from a distinctly glaucous, to a subglaucous green, and the buds always have a rostrate operculum, typically with a long slender beak, but the beak sometimes short and rather thick. It approaches in some forms very closely to *E. Flocktoniae*, and is somewhat difficult to separate from the latter. *E. Flocktoniae* however, as far as I am acquainted with the species, has a distinctly lustrous dark green foliage, broadly expanded base of the operculum, and distinctly urceolate fruits. Its coppice leaves also appear to be distinct.

IV.—THE SURVEY.

In November, 1944, while examining some country to the east of Canna, the first specimen of the var. *borealis* was encountered on an abandoned farm, and, upon examination proved interesting because of the yield and quality of the oil obtained from its leaves. The specimens were determined as *Eucalyptus Kochii* Maiden et Blakely, and the result of the chemical investigations published by Watson (1948). Further investigations instituted by a local firm interested in the subject traced this tree northwards to the Pindar district, and some distance to the east of both localities, with many intermediate records. Further south, in the vicinity of Dalwallinu another form was discovered, extending from the immediate east of Dalwallinu, to the Rabbit-proof Fence, and some little distance to the south, and this proved to be identical with the specimens collected by Max Koch in September, 1904, and named *Eucalyptus Kochii* by Maiden and Blakely. A third, and still more productive form was discovered near Kalannie, a field distillation of fresh twigs giving an oil yield of 3.45 per cent. This is the var. *plenissima*, which was subsequently found to extend from the Rabbit-proof fence near

Pithara southwards to near Ballidu and Kondut, and eastwards to beyond Wialki, Mukinbudin and Campion, and southwards to Korrelocking, Nembudding and Yorkrakine, and has been seen again at Hine's Hill.

The matter was taken up by the Drug Panel of the Department of Industrial Development, and a survey was undertaken of this third variety (var. *plenissima*) and of the var. *Kochii*. This work was commenced in February, 1947, when the above range was outlined, and twenty sites, each representing either distinct forms, or distinct environments, were selected for the two varieties. The var. *plenissima* has the wider range, and the greater number of sites represented this variety. The number was gradually reduced during subsequent collections. Material was collected at three-monthly intervals, in each case from the same tree or mallee, or where this was not possible, for an adjacent plant of similar type. Some were adult mallees and trees, others were smaller more vigorous mallee forms which represented regrowth of approximately 8-10 years, on land which had been previously cultivated for farms, and later abandoned. Others were regrowth taken from young natural regrowth of a metre or less in height; and with these the material in all but one instance (K4), was collected mainly from growth made during the intervals between the collections.

The collecting periods were 4-6th February, 1947; 29th April to 1st May, 1947; 22nd to 24th July, 1947; 5th to 7th November, 1947; 27th to 29th January, 1948, and for the var. *plenissima* 13th to 15th April, 1948. Sites K19 and K20, were established near Nembudding in May, 1947, and the first collections made at that time.

After ten sites had been discarded, the following sites were chosen, and quarterly collections made at the periods stated above:—

- var. *Kochii*.—Site K2. Dalwallinu Fence gate. Tree in loamy depression.
- Site K3. same site. Mallee (adult form).
- var. *plenissima*.—Site K4. Rabbit-proof Fence, 4 miles south from the Dalwallinu gate; regrowth from mallee, in clay soil.
- Site K5. Site of K4; mallee 18 feet tall.
- Site K7. 1 mile N.W. from Kalannie; mallee 10-15 ft. tall, in open places on previously cleared land, in sandy loam.
- Site K7a. Mallee on the K7 site, cut down on the 4th February, 1947; made regrowth as follows:—
 29th April, 27 ins. tall; 22nd July, 28 ins. tall; 5th November, 30 ins. tall; 13th April, 35 ins. tall—the bark much damaged by rabbits.
- Site K10. 7 miles E. from Kulja, on roadside. Mallee 12-15 ft. tall, in red loamy soil on flat.
- Site K11. 7 miles E. from Kulja, on roadside; regrowth 2-3 ft. tall; leaves glaucous.
- Site K18. Yorkrakine. Mallee 4-8 ft. tall, in sandy soil in depression.
- Site K19. 1 mile West from Nembudding Siding; mallee regrowth 1-2 ft. tall, in sandy soil; leaves mostly glaucous.
- Site K20. 1 mile West from Nembudding, in sandy soil; mallee 6-10 ft. tall.

The var. *Kochii* formerly covered wide tracts in the Dalwallinu district, and the same is true for the var. *plenissima*, at least in the Kalannie district. The soils these inhabit are regarded as good agricultural land, and the main evidence of their former extent is to be gained from the prevalence of these plants along the roadsides and on fence lines bordering cultivated areas.

The var. *Kochii*. in the main, inhabits a clay loamy soil, especially in the Dalwallinu country; further south, *e.g.*, Bunketch and towards Ballidu, it is found in sandy loamy, or sandy soil. Its associated plants in the typical environment are *Acacia acuminata* Benth. (shrubby form); *Melaleuca uncinata* R.Br., *Acacia Graffiana* F. Muell. and *Eremophila Drummondii* F. Muell. and usually *Grevillea Huegelii* Meissn. The tree form and the mallee form are usually associated, and wherever this variety has been found, most of the country has been cleared for agricultural purposes, and much of it subsequently abandoned. Unlike many mallees, the subterranean stock is easily broken up or dislodged by the plough, so that the regeneration in cultivated land is surprisingly low. The same remark applies to the var. *plenissima* which is comparatively rare on country previously denuded of vegetation and subject to the plough.

The var. *plenissima* enjoys a wider range, and inhabits a greater variation in soil types than does the var. *Kochii*. Like the var. *Kochii* it is most frequently associated with *Acacia acuminata* Benth. and *Melaleuca uncinata* R.Br., but it is also found in sand-plain country, and on heavy forest soil associated with *Eucalyptus redunca* and with *E. foecunda*. In the eastern areas of its known distribution it is found as a small stunted tree with tortuous branches and coarse foliage in red sand associated with *Callitris glauca*. It is remarkable amongst the dry country mallees for the density of its foliage and its rich branching. Until the plants attain a height of about six or eight feet they are densely branched from the base, forming dense globular shrubs; as the upper branches develop, the lower branches die, and in mallees in the transitional stage, there is usually a mass of closely growing dead branches around the stock. The branchlets of the young mallees are weak and spreading or drooping, and commonly a deep red in colour; the flowering and fruiting branches and branchlets, and those of the upper parts of the mallees, and the trees also, are pale in colour. The density of the branches and the foliage in the younger mallees makes them readily recognisable among their congeners, and prove the most outstanding features of the plant.

NOTE.

Since the above was written, I have received from Miss N. T. Burbidge, an excellent photographic representation of the sheet in the Utrecht Herbarium, which is regarded as the type. This photograph clears up a few points that were previously doubtful. It shows three twigs: the largest (upper right hand side) is indubitably *E. uncinata* Turcz., showing leaves and flowers; below this is a fragment showing small leaves and flower-buds, also *E. uncinata* Turcz. On the left-hand side is *E. oleosa* showing super-floral leaves, and lateral umbels with advanced flowers; there are neither buds nor fruits. The label is as follows:—

“ *Eucalyptus oleosa* F. Mull.
Marble range (Wilhelmi)
Murray Scrub
Novo Holl. austr.
F. Muller.”

It will be noticed that Behr's name is not included.

Regarding the specimen of *Eucalyptus oleosa* the following features are well illustrated by the photograph: the leaf lamina varies from 4.5–5.6 cm. in length, and about 9–10 mm. in breadth. The leaves are copiously dark-punctate with prominent oil-cavities, the midrib is conspicuous, and the secondary nervation evident; the intramarginal nerve is well removed from the margin of the leaf. I would describe the shape of the leaf as varying from lanceolate to oblong-lanceolate, attenuate and slightly oblique at the base, the apex shortly acuminate and ustulate-uncinate. The peduncles are distinctly thickened upwards; the umbels are up to 8-flowered; the immature fruits hemispherical-cupular (probably becoming globular-hemispherical at maturity), 4–5 mm. in diameter, and about as much in length. The disc would probably be rather prominent. On two inflorescences the peduncle appears to show a pale decorticating cortex; the immature fruits are abruptly contracted into rather slender pedicels which vary in length from slightly shorter than, to longer than the calyx-tube.

It is evident that the original description was drawn up from the specimens of both species (*E. uncinata* and *E. oleosa*). The breadth of the leaf, the number of flowers in the umbel, "shortly pedicellate or subsessile," and the opercula, are all taken from Wilhelmi's specimens (represented in the Melbourne Herbarium by specimens from the Marble Range, north of Port Lincoln). All that we can be certain about regarding *E. oleosa* in the original description, is the statement attributed to Behr "Shrub the height of a man; leaves a very pleasing shining green." There is, however, nothing on the Utrecht sheet to indicate that the specimen is Behr's; the label suggests that Mueller collected it himself in Southern Australia.

There appears, therefore, some doubt as to the propriety of regarding the species as valid, but, if *Eucalyptus oleosa* is to be retained, then the inadequate material on the Utrecht sheet is apparently the type (*i.e.*, that portion of the sheet which represents *E. oleosa*, and not *E. uncinata*), and although Behr is not shown to be the collector, his remarks which were included in the original description, should be taken into account, and these, as far as the descriptions indicate, apply to, and only to, the Green Mallee of the Pinnaroo district. Apart from this, the original description, based upon two species, applies more to *E. uncinata* Turcz., than to *E. oleosa* F. Muell.

V.—THE ESSENTIAL OILS.

Volatile oils from three Western Australian varieties of *E. oleosa* F. Muell. have already been described. The oil of variety *longicornis* was described by Baker and Smith (1920) who had distilled it from material collected from trees cultivated in the Melbourne Botanical Gardens. The oil of variety *obtusa*, the so-called giant black mallee of the south-eastern goldfields, was the subject of a paper by Marshall and Watson (1936–37). The oils from three samples of *E. Kochii* Maiden et Blakely, which are now recognised as specimens of *E. oleosa* var. *borealis*, were dealt with in a brief preliminary note by Watson (1948).

The oils described in the present paper are from the varieties *borealis*, *Kochii* and *plenissima*.

Yield.

The oils were steam distilled from thoroughly air dried branchlets and the percentage yields were calculated from the air dried weight. A series of tests carried out on material collected at the end of April and the beginning

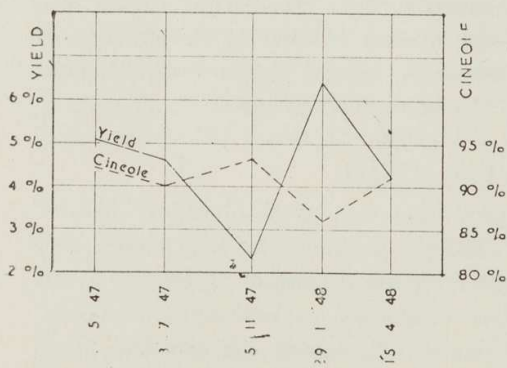
of May, 1947, showed that the loss of weight on drying the varieties *Kochii* and *plenissima* varied from 38 to 42 per cent., averaging a little over 40 per cent. The results of the oil distillations are summarised in Table 1.

TABLE 1.

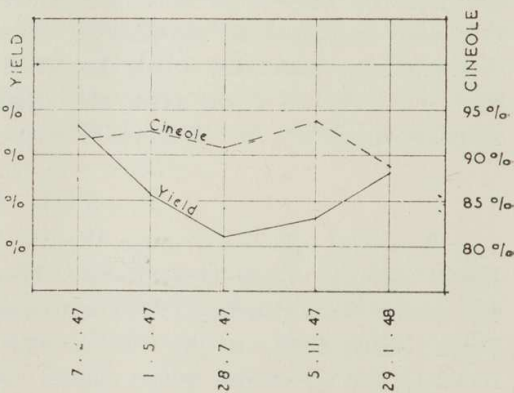
Variety.	Number of specimens.	Time Collected.	Percentage yield.	
			Range.	Average.
<i>borcalis</i>	13	End of November to January	2.1-4.7	3.0
<i>Kochii</i>	23	Three monthly intervals	2.3-5.5	3.5
<i>plenissima</i>	49	Three monthly intervals	2.2-8.6	4.2

The yield from var. *plenissima* is significantly higher than those from the other two varieties.

There is in general a marked seasonal variation in yield, a defined "flush" period occurring in the first half of the summer, probably reaching a maximum in January. This is shown clearly by specimen K20 (var. *plenissima*), a mature mallee occurring 6 miles east of Korrelocking, the oil yield from which increased from 2.5 per cent. on 5th November, 1947, to 6.4 per cent. on 29th January, 1948, and then fell to 4.2 per cent. by 15th April, 1948 (text fig. 1). The summer maximum is not always as well defined as this. For example, K18 (var. *plenissima*) from Yorkrakine showed a summer maximum of 4.7 per cent. and a winter minimum of 2.2 per cent., with a much slower rate of change (text fig. 2).

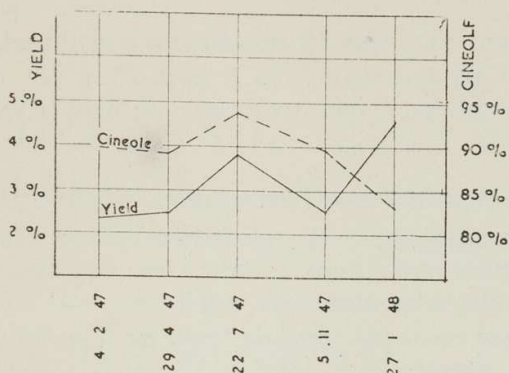


Text Fig. 1, K20, Korrelocking.
Var. *plenissima*.



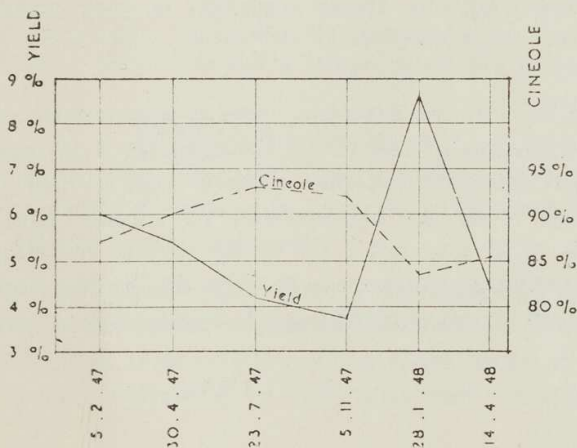
Text Fig. 2, K18, Yorkrakine.
Var. *plenissima*.

Two specimens of var. *Kochii* (K2 and K3), examined regularly from 4th February, 1947, until 27th January, 1948, showed, in addition to the summer maximum, a second peak in mid-winter (text fig. 3). Examination of the weather records for the locality gave no indication of any difference in weather conditions compared with those at other sites likely to account for the production of a winter peak. Indeed, specimen K4 (var. *plenissima*), which was collected only 2 miles from K3, showed the typical winter minimum observed with all other specimens of var. *plenissima*.



Text Fig. 3, K2, Dalwallinu.
 Var. *Kochii*.

The yield obtained from regrowth, following the cutting or burning of mallees to the ground, is invariably higher than that obtained from mature mallees or trees, and the "flush" period is very clearly defined. Thus K11 (regrowth, var. *plenissima*) (text fig. 4), gave a minimum yield of 3.7 per cent. on 5th November, 1947, rising to a maximum of 8.6 per cent. on 28th January, 1948, and falling to 4.3 per cent. by 14th April. Similarly K19 (regrowth adjacent to K20) showed a minimum of 3.6 per cent. on 5th November, 1947, rising to a maximum of 7.2 per cent. by 29th January, 1948.



Text Fig. 4, K11, Kulja.
 Var. *plenissima* (Regrowth).

*Physical Properties.**

Physically there is little difference between the oils of the three varieties. Specific gravities varied from 0.919 to 0.927, refractive indices from 1.4590 to 1.4630 and specific rotations from +0.45° to +3.80°. A reasonably close agreement was shown between specific gravity and cineole content, a high specific gravity almost invariably indicating a high cineole content. The oils of lower cineole content were always those of higher refractive index and higher optical rotation.

Chemical Properties.

Chemically, principal interest has centred in the cineole contents of the oils. Work on the minor constituents is in hand. The variety *borealis* has only been examined during the summer months from the end of November

* Physical properties are given at 20°C.

to the end of January. Of the 13 specimens examined, two showed cineole contents of less than 80 per cent. (72.8 and 75.4 per cent.), the remaining 11 giving an average of 88.3 per cent. cineole and a maximum of 92.8 per cent.

The variety *Kochii* has been examined regularly since the beginning of 1947. A number of specimens was collected in January and February and two selected typical specimens (one a tree and the other a mallee) were examined at three monthly intervals until the end of January, 1948. In 23 oils analysed, cineole contents ranging from 82.7 to 93.8 per cent., averaging 84.8 per cent., were found.

The variety *plenissima* has been examined over much the same period. In 49 specimens analysed, the cineole contents varied from 83 to 94.8 per cent. and averaged 89.5 per cent. Oils distilled from 20 specimens, collected during the summer months of February and November, 1947, and January, 1948, from 7 sites, give an average cineole content of 89.5 per cent. The summer oils are therefore not distinguishable from those obtained over the entire period.

There is, then, comparatively little difference between the oils from the varieties *borealis* and *plenissima* and, although the average cineole content of the oil from variety *Kochii* is about 5 per cent. less than that of the other two, the range shown by the three varieties is very similar.

Regrowth.

The mallee (K7a, var. *plenissima*), which was cut down on 18th January, 1947, gave, on distillation of the dried branchlets, 3.95 per cent. of oil which contained 94.8 per cent. of cineole. Three and a half months later (29th April), the regrowth from the stump was 25 inches high and consisted of numerous fascicles of shoots with 10 to 20 shoots in each. Fifteen months after the original cutting, the regrowth was 35 inches high and gave on distillation 6.4 per cent. of oil containing 91.3 per cent. of cineole.

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